# Bamboo plants inventory at barangay baganihan in marilog district, davao city, Philippines: The first step in the adopted community's lab-bayong Sustainability project




## ABSTRACT

**Aims:** The goal of the study was to establish baseline data on bamboo species inventory and diversity, and soil suitability area at Barangay Baganihan, Marilog District, Davao City to support the community's LAB-BAYONG sustainability project.

**Study design:** Descriptive design with a quantitative methodology to inventory bamboo species was utilized. Field surveys were conducted to identify bamboo species to the lowest taxonomic level utilizing morphological traits and taxonomic keys. The frequency and relative frequency of each bamboo species were documented and species diversity was evaluated. Soil characterization analysis of soil texture, pH, and macronutrient concentrations (nitrogen, phosphorus, and potassium).

**Place and Duration of Study:** The adopted community of Barangay Baganihan, Marilog District, Davao City, was the site of this study. Its coordinates are 7o28'26"N and 125o14'36"E. One shot sampling was done on September 2024 to account the bamboo present in the study site.

**Methodology:** Two Belt Transects were established with 20m X 20m off the access route and marked with GPS running perpendicular to the access routes for at least 200 m with the direction recorded. Photographs were also made from actual observations in the field sites of bamboo plants in their natural habitat. To achieve information about the general soil conditions of the research site, soil texture, Soil pH and NPK (Nitrogen, Potassium and Phosphate) were examined.

**Results:** The results indicated a low density for both mature and young specimens of *Cephalostachyum mindorense*, often known as climbing bamboo. The sampling locations exhibit a soil composition ranging from coarse sand to clay, with a pH level between 5.0 and 6.5. The concentrations of Total Nitrogen (N), Total Phosphorus (P), and Total Potassium (K) are recorded at 0.31%, 1.8 ppm, and 75.9 ppm, respectively.

**Conclusion:** *Cephalostachyum mindorense*, the only recognized species, has little diversity and a high proportion of mature plants. The soil physico-chemical analysis revealed the potential for bamboo growth, although potassium (K) levels need to be improved.

***Keyword:*** *bamboo resources, craft production, liveliood opportunities, physico-chemical properties, sustainability*

## 1. INTRODUCTION

The Bachelor of Science in Biology Program of San Pedro College in Davao City, Philippines, created the "LabBayong" Project, which empowers female weavers in Barangay Baganihan, Marilog District, by allowing them to develop and weave laboratory bag kits from bamboo. This project promotes livelihood growth and cultural preservation in the community. However, the LabBayong project's long-term success depends on the ongoing availability of a sustainable bamboo supply.

Concerns are growing about the availability and richness of bamboo resources. Overexploitation, habitat degradation, and unsustainable harvesting practices have led to the reduction of bamboo populations in Nepal, Mexico, and Cameroon (Ayer et al., 2023; Nfornkah et al., et al., 2023; Rodríguez Marín et al., 2023). For example, in Nepal, while bamboo provides a variety of ecosystem services and is critical for local livelihoods and climate resilience, there is a lack of comprehensive data on conservation status and ecosystem services, indicating the need for more detailed research on these topics (Binfield et al.,2022). Similarly, despite Cameroon's tremendous bamboo potential for carbon sequestration and human well-being, the country has yet to ultimately reap the benefits of forest landscape restoration and climate change mitigation (Kaam, et al, 2023). The scarcity of bamboo jeopardizes the viability of programs like LabBayong, which rely on this natural resource to empower local populations.

The variety and accessibility of bamboo resources in Barangay Baganihan are critical to the Lab-Bayong project's survival. To evaluate the possible output and quality of raw materials for the production of laboratory bag kits, a thorough inventory of bamboo species is essential. A lack of bamboo species diversity could jeopardize the project's long-term sustainability by making it more susceptible to pests, illnesses, and climate change. Inadequate bamboo resources may also result in overuse and forest degradation, which would have a detrimental effect on the local ecology and the livelihoods of the local population. To make sure that sustainable harvesting methods are used and that this valuable resource is protected, it is important to know what kind of bamboo is growing in Barangay Baganihan right now.
Furthermore, published data on individual bamboo species and their abundance in Davao City, notably Barangay Baganihan, is limited. This lack of understanding impedes efficient management and conservation efforts for these critical resources (Dela Cruz et al., 2001). To address these knowledge gaps and ensure the LabBayong project's sustainability, this study conducts the first inventory of bamboo plants in Barangay Baganihan. This research seeks to create a baseline understanding of bamboo species diversity and abundance to influence future management and propagation efforts.

This project has several important objectives, including creating a baseline inventory of bamboo species and their abundance in Barangay Baganihan. This initial evaluation will give critical data on the existing bamboo resources and their potential to support the LabBayong project, as well as an assessment of soil conditions conducive to bamboo growth. Understanding the soil properties is critical for establishing effective propagation procedures and guaranteeing optimal bamboo growth. Finally, investigate viable propagation procedures to provide a steady supply of bamboo for the LabBayong project. This study can help the project's long-term viability by discovering appropriate propagation strategies and empowering the female weavers of Barangay Baganihan.

## 2. MATERIAL AND METHODS

### 2.1 Research Setting

The adopted community of Barangay Baganihan, Marilog District, Davao City, will be the site of this study. Its coordinates are 7o28'26"N and 125o14'36"E. The Matigsalog tribe predominately inhabits Barangay Baganihan. 1,295 people were living on vthe said barangay as of the 2015 Census. This amounted to 0.08% of Davao City's entire population. The age group in Barangay Baganihan with the biggest population, according to the 2015 Census, is 5 to 9 years old, with 172 people. On the other hand, there are only 3 people in the age range 75 to 79, which has the lowest population. On the island of Mindanao, Baganihan is situated at around latitude and longitude 7.3985 and 125.3165. At these coordinates, the elevation is thought to be 514.8 meters, or 1,689.0 feet, above mean sea level.

One shot sampling was done to account the bamboo present in the study site. The sampling was done in a favorable condition where plants and sites were not exposed to run offs. There was no collection of species since the identification of the species was done in situ. The extent of establishing the belt transect was also validated by the local and the villagers.

### 2.2 Establishment of Sampling Stations

Two Belt Transects were established with 20m X 20m off the access route and marked with GPS running perpendicular to the access routes for at least 200 m with the direction recorded. A maximum of 20m x 20m plots were established on alternate sides of each Belt Transect for assessment of the bamboo. Ranging rods, Transect tape, hand held compass and flagging tapes were also used to establish and mark the plots. A distance of 50 m separated each of the plots. The plots were geo referenced with GPS and later mapped for monitoring. Within the plots, the number of live (fresh) and dead or dry bamboo culms rooted within the plots were counted to assess the abundance and distributions. The number of clumps (groups of bamboo growing together) were recorded. Diameter at breast height (dbh, 1.3 m high) for the live and dead or dry culms was done using Millimeter Vernier Calipers. The record will indicate whether the individual is shoot, young, mature or old culms/ stems. The number of cut stems will also be recorded to obtain estimates of the current levels of harvesting in terms of intensity. Standard data sheets will be used to record the data in readiness for analysis to assess the abundance and distribution (Enyagu et al, 2020).

The establishment of two 20x20 quadrants as sampling plots for the bamboo inventory was meticulously rationalized, considering ecological factors and project-specific requirements. The survey sites were intentionally chosen to concentrate on regions where *Cephalostachyum mindorense (C. mindorense)* naturally occurs, as it is the sole species of bamboo employed in the lab bag kits and associated products developed under the Lab-Bayong Sustainability Project.

The decision to establish only two quadrants was guided by several factors, with the first being Ecological Relevance. *C. mindorense* exhibits a non-uniform distribution throughout Barangay Baganihan. The sampling focused exclusively on regions where this species is recognized to flourish, thereby ensuring that the inventory is consistent with the project's goals of sustainable use of the bamboo species. Setting up plots in these particular locations ensures that only relevant bamboo species are included, thereby enhancing the focus and efficiency of the study. The next focus is on the Project Scope and Resource Allocation. The Lab-Bayong Sustainability Project highlights the importance of sustainable harvesting methods for C. mindorense. The two plots were considered adequate to obtain a representative sample of the population, considering the logistical and resource limitations of the project. The plots facilitated a precise evaluation of the bamboo population while minimizing disruption to the ecosystem, culminating in the Community Input and Verification process. The identification of the natural growth sites of *C. mindorense* relied heavily on local knowledge. The restricted number of quadrants was guided by community insights, which emphasized particular regions where the bamboo species is mainly located, ensuring the plots accurately represented the distribution of the target species.

### 2.3 Identification of Bamboo Species

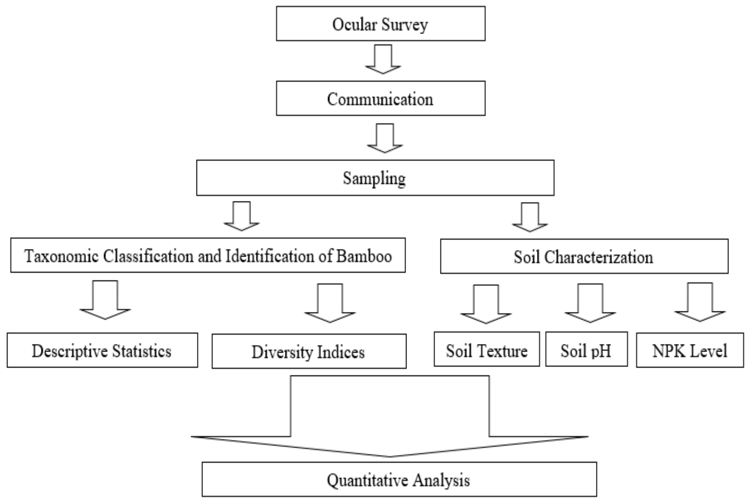
All the bamboo plants were identified during sampling and the location site were tagged using Global Positioning System (GPS). Plants were documented for proper taxonomic classification up to species level. Photographs were also made from actual observations in the field sites of bamboo plants in their natural habitat. Checklists of bamboo were also prepared in support for easy accessibility on the profile of records. The identification of bamboo plants up to species level at field were aided by some manuals, taxonomical keys such as the Digital Flora of the experts particularly “The Handbook for Erect Bamboo Species Found in the Philippines” for proper taxonomic classification, and was validated by expert for proper taxonomic classification and identification up to species level.

### 2.4 Soil analysis

To achieve some information about the general soil conditions of the research areas, some physical and chemical properties of soil were analyzed after the sampling collection. The soil samples were taken at the depth of 35 cm because the soil layer from the ground to 35 cm is obviously important for bamboo growth due to the rhizome systems of most bamboo species developing at that depth (Fu, 2001). The investigated parameters of soil are the following: Soil texture (sand, silt and clay, presented in %) • Soil pH • Major nutrients (Nitrogen, Potassium and Phosphate).

### 2. 5 Research Procedures

**Fig 1:** The schematic diagram below shows the flow of the study:




### 2. 6 Data analysis:

Bamboo species were classified to the most specific taxonomic level using morphological characterization and taxonomic keys. The composition of species was evaluated by calculating frequency and relative frequency, whilst species diversity was examined through species richness and the Shannon-Wiener Diversity Index. The distribution of bamboo species in the research region was mapped, and percentage coverage was quantified to assess the level of bamboo presence. Furthermore, soil characterization was conducted by the analysis of soil texture, pH levels, and NPK (nitrogen, phosphorus, and potassium) content to evaluate soil fertility and its possible impact on bamboo dispersion. The results offered an extensive insight into bamboo variety and ecological conditions, establishing a foundation for conservation and sustainable management initiatives in the region.

## 3. RESULTS AND DISCUSSION

### 3.1 Bamboo Plant Identification

*Cephalostachyum mindorense* or climbing bamboo was the only species found in the sampling site as shown in Table 1. Most of the counts were young shoots of bamboo over the presence of matured bamboo plants. Results showed low density for both mature and young bamboo sampled in the area. Some studies presented high densities for forested areas, WWF 2014 reported hundreds of clumps, mature and young bamboo were found in a 20m x 20m transect. Fu et al 2022, mentioned endophytic fungi have strong influence on bamboo forest which will lead to increased bamboo plant diversity and richness. It was observed during the collection that the bamboo plants have few presence of endophytes. Thus, it affects the turnover of the bamboo plant to have new recruits. Bawer 2015, reported a varied diversity index of sampling sites of North Luzon affected by turn overs due to the absence of endophytic organisms. The calculated H value is zero which indicates that the species abundance and diversity is at stake. This is also because the locals valued the presence of this commodity for its convenience. According to Chao (2013) species may not grow rich in number as well as the increase of diversity, due to its nature and its natural requirement. In this study, this bamboo species may grow to these sites for some physical and chemical environmental needs.

Table 1. Frequency Distribution of C. mindorense.

| Belt # | *Cephalostachyum mindorense* | Frequency | Density | Percentage Frequency |
|---|---|---|---|---|
| 1 | Mature | 31 | 0.0775 | 39.14% |
| 2 | Mature | 132 | 0.33 | |
| 1 | Young | 86 | 0.215 | 60.86% |

Whilst diversification of commodities are promoted by ecologists and conservationists to sustain the resources both economically and socially, the sampling sites deviates this norm to address the necessities of the adapted community. The recurrent utilization of *C. mindorense* or climbing bamboo among the stakeholders of the community fuels the proponents to propagate more of this resource in a monospecific approach. This resource is harvested more often as a raw material for handicrafts to be sold. In addition, the physico-chemical results of the soil are seemingly promoted to propagating climbing bamboo.

The documentation of a single bamboo species at the sampling site in Barangay Baganihan carries important implications for biodiversity and ecological health.According to Jeno et al. (2023), the fact that there is only one species of bamboo *(Cephalostachyum mindorense*) could mean that biodiversity is decreasing, making the environment less stable. Bamboo species play a significant role in providing various ecosystem services, such as carbon sequestration and soil stabilization. Insufficient diversity could impede these functions, affecting the overall health of the environment (Saikia & Pandey, 2020). There aren't many species of bamboo left, which could hurt local communities that use different species for their traditional activities and businesses, for example, the Matigsalug tribe uses a variety of plants (Guevara & Garcia, 2018).

Bamboo's species diversity may limit the range of products and services it can provide. The fact that there were not many species seen suggests that the sampling site may not have a lot of different kinds of bamboo. This could be because of habitat fragmentation, human disturbance, or natural variation.Studies that show a link between low diversity and unstable ecosystems (Jeno et al., 2023) show that a lack of species richness may mean that the environment isn't good enough.

The frequency with which immature bamboo stands are replaced by older bamboo stands highlights the importance of community-based initiatives to propagate bamboo species to ensure their long-term viability (see table 1). Bamboo is known for its rapid growth, with some species growing up to one meter per day (Zhang, 2023). This rapid turnover of bamboo stands is attributed to the fact that bamboo is known for its rapid growth. Furthermore, the immature bamboo stands have the potential to mature rapidly, which enables a sustainable harvest cycle that can be beneficial to the economies of the surrounding areas (Zhang, 2023). The efficient allocation of biomass to rhizomes is another aspect that contributes to the rapid turnover (Kobayashi et al., 2022). This component improves growth and resource storage, contributing to the rapid turnover.
The rapid expansion of bamboo gives prospects for economic development; nevertheless, it also presents concerns, such as the possibility of overexploitation if it is not handled appropriately. For this reason, encouraging community participation in bamboo propagation is

necessary for ensuring the plant's long-term viability. According to Liang et al. (2024), the process of propagating bamboo species can assist in the maintenance of the equilibrium between young and mature stands, hence reducing overharvesting and maintaining a continual supply. The participation of the community in the growth of bamboo has the potential to increase the local biodiversity and give economic benefits via the use of sustainable practices (Zhang, 2023).

On the other hand, other species like *Dendrocalamus brandisii* is an important bamboo species noted for its various applications and ecological advantages. This species functions as a sustainable substitute for wood and plastic while also being vital to other industries, such as construction and medicine. These species contribute to carbon sequestration, are employed in construction due to their great tensile strength and quick development, and their capacity to survive in varied conditions renders them good candidates for sustainable forestry operations.*Dendrocalamus brandisii* presents several benefits; nonetheless, issues include market adoption and the necessity for enhanced breeding procedures are pivotal for optimizing its potential across diverse sectors.

### 3.2 Soil pH & NPK Levels

The laboratory test of soil samples, as shown in Table 2, indicated variability in NPK levels and soil pH throughout the research area. The sampling sites display a soil pH range of 5.0 to 6.5. The contents of Total Nitrogen (N), Total Phosphorus (P), and Total Potassium (K) are documented as 0.31%, 1.8 ppm, and 75.9 ppm, respectively. These findings offer critical insights into the soil fertility status and its possible influence on bamboo development in Barangay Baganihan.

Table 2. NPK and Soil pH Laboratory Analysis Results

| Soil Parameters | Actual Value | Reference Value | Method |
|---|---|---|---|
| Total Nitrogen (N) | 0.31% | 0.036 | Kjeldahl |
| Total Phosphorus (P) | 1.8 ppm | 10-20 ppm | Modified Troug |
| Total Potassium (K) | 75.9 ppm | 50-200 ppm | Extraction-AAS |
| pH | 6.54 | 5.0-6.5 | Glass Electrode |

The soil plays a vital role as a growing substrate for plants, and is the main source of nutrients. Macabiog, et al. (2020) stated that the three essential elements that plants require in the greatest quantities are nitrogen (N), phosphorus (P), and potassium (K). For plants to grow to their full potential and produce high-quality crops with increased yields or productivity, there should be enough of these nutrients in the soil (Guan, F., Xia, M., Tang, X., & Fan, S., 2017).

In terrestrial ecosystems, nitrogen (N) is frequently a significant component for plant productivity and growth but also considered as a limiting nutrient. For bamboo plants, this nutrient is essential since it is critical to their development, vitality, and general health. Ammonium ($NH_4^+$) and nitrate ($NO_3$) are the two main forms of inorganic N that plants can access in soil naturally (Xu, Fan & Miller, 2012). In the results of Chopan et al 2018, nitrogen is one of the important micronutrients for increasing growth and biomass production in *Moso* bamboo *(Phyllostachys* pubescent) seedlings. Their research concluded that 0.018 ppm or 18g of nitrogen per shoot per week is recommended as the suitable fertilizer dose for farmers to grow high-quality plants and increase the growth of *Moso* bamboo plants. Another study by Xu, Z. et al (2022) showed that nitrogen is an important indicator of plant health and measuring nitrogen content is the key to pest monitoring in Moso bamboo forests. The same study found that as insect damage to Moso bamboo plants increased, total leaf nitrogen decreased, making nitrogen an important indicator for controlling plant pests. Results of the current study showed 0.036ppm (see table 2) of Nitrogen found in a kg of soil sample. This implies that the nitrogen level of the sampling site is not a limiting factor and is suitable to grow *C. mindorense.* In forest ecosystems, Phosphorus is a crucial macronutrient for plants that is required for both growth and development. According to the study of Hu, X. et al. of 2022, 10–20 ppm of P in the soil is ideal for bamboo growth as it fosters growth and general plant health. This is supported by the study of Li et al of 2022, showing that optimum phosphorus value has a favorable effect on the nutritional content and growth of Dendrocalamus asper, or giant rough bamboo promoting better development of their leaves and roots. The P level of the current study reveals low concentration (see table 2), that might lead to low recruitment and turnover of the bamboo plant.

Low phosphorus levels may be detrimental to the quality of the soil and the growth of bamboo. Among these include inhibition of Nitrogen absorption by roots (Guo, Z.et al,2014), decrease soil mineralization (Qian, Z.,et al.2021), and reduced biomass allocation in the roots, leaves, and stems (Dunaiski, F. A. et al, 2019). For soil with lower phosphorous level, the innovation of the bamboo charcoal process is utilized in soil that is advantageous for plant growth (Chen, L et al., 2021).

For bamboo to achieve photosynthesis and plant metabolism, there must be sufficient potassium in the environment (Koralage et al., 2015). According to a study by Samadhi et al. (2018), bamboo should have between 50 and 200 ppm of potassium in their soil. This range is sufficient to enable growing plants to fend against diseases and maintain general health. The findings of this investigation showed that the sampling site's potassium level is 75.9 ppm, and within the advised range. This promotes the survival and growth of the single species found at the sampling site, *Cephalostachyum mindorense*, or climbing bamboo.

The optimum pH level of the soil for growing bamboo varies based on the species and how it is managed. Studies reveal that bamboo growth and soil quality are significantly influenced by the pH of the soil (Mbukwa, D. et al, 2023). A pH of more than 5.0 is advised for Lei bamboo in order to promote healthy growth and avoid soil acidification (Liu et al 2020). Furthermore, research has demonstrated that the invasion of bamboo can raise the pH of the soil, emphasizing the significance of taking into account how plant invasion affects pH levels in the soil (Maliang et al 2020). Results showed that the area has the suitable soil pH required by bamboo plants to grow at optimum level. In other areas, a liming approach is implemented to reduce soil acidity and raise soil pH, both of which can promote bamboo growth. Thus, keeping the pH of the soil between 5.0 to 6.5—which is slightly acidic to neutral—is generally advised for successful bamboo growing, taking into consideration the particular bamboo species and environmental conditions.

Aside from NPK minerals, Lathwal et al. (2023) examine the impact of bamboo biochar on the growth and biomass distribution of *Bambusa balcooa* in soils contaminated with copper. The results demonstrate that bamboo biochar substantially alleviates the detrimental impacts of copper poisoning, improving many growth metrics. This study emphasizes the promise of bamboo biochar as a sustainable additive for enhancing plant resistance in polluted settings.

**3.3 Soil texture and grain size analysis.**

Soil and water are essential for the plants to grow. Soil plays a vital role to hold essential resources needed by plants. The soil formation process influences several factors such as climate, microorganisms, vegetation, and land elevation. Soil water retention capacity includes the texture (table 3) which influences the surface permeability where provision of possible adsorption of micronutrients (table 2) to the plants. The data showed that the soil type of the sampling sites varies from coarse sand to clay, this means that the soil sample capacitates to retain water and essential nutrients. In the study of Gusler and Demir 2010, organic matter increases the soil's capacity to hold water by direct absorption of water. They also mentioned enhancing the formation and stabilization of aggregates containing the abundance of pores that can hold water under moderate tensions. The data exhibits that the soil of the area varies from clay to coarse sand which entails that the soil is well sorted and viable to grow plants. The same results were noticed in the study of Brogowski et al 2015, that binding water suits best with soil with <0.02 mm in size which he explained that it significantly depends on the mineralogical composition of fractions. Results of the study showed varied values of sieved soil from the bamboo site. This may imply that the area will favor growth of bamboo plants and is suitable for bamboo propagation.

Table 3. Grain size analysis of the collected soil sample from Bamboo plant site Baganihan, Marilog District.

| Sieve Number | um | mm | Soil collected (g) | Soil Type |
|---|---|---|---|---|
| 25 | 710 | 0.71 | 163.2 | Coarse sand |
| 20 | 850 | 0.85 | 106.29 | Medium sand |
| 40 | 425 | 0.425 | 5.19 | Fine sand |
| 80 | 180 | 0.18 | 76.09 | Coarse silt |
| 120 | 125 | 0.125 | 30.49 | Fine silt |
| 170 | 90 | 0.09 | 21.37 | Very fine silt |
| Pan | | | 16.75 | Clay |

## 4. CONCLUSION

The following are the conclusions drawn from the findings of the study:

1. *Cephalostachyum mindorense* or climbing bamboo is the only species of bamboo plants found in the sampling area with its young and mature plants.
2. The inventory of bamboo species in the area shows a very low value based on the Shannon-Diversity Index. The young species of *Cephalostachyum mindorense* has a total percentage frequency of 39.14% while its mature plants is 60.86%.
3. The soil physico-chemical parameters such soil texture, soil pH, & NPK levels measured in the sampling area has the potential to grow the bamboo plants.

The following are the recommendations based on the following results:

1. Use bamboo taxonomy experts to conduct a comprehensive study of the area to identify and describe any additional bamboo species, even in small quantities. This will improve bamboo biodiversity evaluation.
2. To sustain the lab-bayong making project, further research is needed to discover *C. mindorense* bamboo plant cultivation strategies. Use culm cutting and tissue culture to propagate new plants and restore deteriorated regions.
3. Improve soil fertility, especially potassium (K), to boost bamboo growth and output. This may require organic fertilizers or soil additions.

4. Conduct research on introducing bamboo species with improved resilience, faster growth, or superior features for specific purposes. Diversification reduces pressure on *C. mindorense* and improves bamboo sustainability.
5. Implement rigorous bamboo harvesting standards, especially for young culms. Community-based monitoring, licensing, and fines for overharvesting and overexploitation may be used.

## ETHICAL APPROVAL

The study complied with ethical standards by conducting all research operations with regard for the environment, local populations, and scientific integrity. Before data collection, requisite approvals were obtained from local authorities and pertinent agencies to perform the inventory of bamboo species in Barangay Baganihan, Marilog District, Davao City. The study utilized non-destructive sample techniques whenever feasible to reduce environmental impact, and all soil sampling was conducted judiciously to avoid habitat disruption. Furthermore, local expertise and perspectives were recognized, guaranteeing that traditional ecological knowledge was honored and attributed correctly. Data collection and analysis were executed with precision and transparency, and results were presented impartially to aid in biodiversity conservation and sustainable management.

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1. Quilbot- - this application tool is utilized to paraphrase text while preserving its original meaning.

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